The ToxGuide™ is developed to be used as a pocket guide. Tear off at perforation and fold along lines.

Sources of Exposure

General Populations

- Exposure of the general population to lead is most likely to occur through the ingestion of contaminated food and drinking water. Exposure can also occur via inadvertent ingestion resulting from contact with contaminated soil/dust or lead-based paint.
- Lead can leach into drinking water from lead-soldered joints or leaded pipes in water distribution systems or individual houses. Lead may also enter foods if they are put into improperly glazed pottery or ceramic dishes.
- Many non-Western folk remedies used to treat diarrhea or other ailments may contain substantial amounts of lead. Some types of hair dyes and cosmetics may contain lead compounds.
- Exposure may also result from engaging in hobbies that use lead: casting ammunition and making fishing weights; soldering with lead solder; making stained glass. Use of lead ammunition may result in exposure to lead dust generated during gun or rifle discharge.

Occupational Populations

- Potentially high levels of lead may occur in the following industries: lead smelting and refining industries, battery manufacturing plants, steel welding or cutting operations, construction, rubber products and plastics industries, printing industries, firing ranges, radiator repair shops and other industries requiring flame soldering of lead solder.

Toxicokinetics and Normal Human Levels

Toxicokinetics

- Approximately 95% of deposited inorganic lead that is inhaled is absorbed.
- The extent and rate of gastrointestinal absorption of inorganic lead are influenced by the physiological state of the exposed individual.
- Gastrointestinal absorption of lead is higher in children (40–50%) than in adults (3–10%). The presence of food in the gastrointestinal tract decreases absorption.
- Absorption of lead from soil is less than that of dissolved lead, but is similarly depressed by meals (26% fasted; 2.5% when ingested with a meal).
- In adults, about 94% of the total amount of lead in the body is contained in the bones and teeth versus about 73% in children.
- The elimination half-lives for inorganic lead in blood and bone are approximately 30 days and 27 years, respectively.
- Independent of the route of exposure, absorbed lead is excreted primarily in urine and feces.

Normal Human Levels

Blood

1.7 µg/dL (geometric mean, children, 1-5 years of age, NHANES 2001-2002).
1.56 µg/dL (geometric mean, adults, ≥20 years of age, NHANES 2001-2002).

Urine

0.677 µg/dL (geometric mean, age 6 and older, NHANES 2001-2002).

Biomarkers / Environmental Levels

Biomarkers

- Analysis of lead in whole blood is the most common and accurate method of assessing lead exposure. Erythrocyte protoporphyrin (EP) tests can also be used, but are not as sensitive at low blood lead levels (≤20 µg/dL). Lead in blood reflects recent exposure.
- X-ray fluorescence techniques (XRF) can be used for the determination of lead concentration in bones. Bone lead measurements are a good indicator of cumulative exposure.
- Measurements of urinary lead levels and hair have been used to assess lead exposure, however, they are not as reliable.

Environmental Levels

- Data from the EPA National Air Quality Monitoring Program indicated that the 2002 average air quality concentration for lead is below 0.05 µg/m^3.
- Levels of lead in surface water and groundwater throughout the United States typically range between 5 and 30 µg/L.
- The natural lead content of soil derived from crustal rock, mostly as galena (PbS), typically ranges from <10 to 30 µg/g soil.

Reference

Agency for Toxic Substances and Disease Registry (ATSDR). 2005. Toxicological Profile for Lead (Draft for Public Comment). Atlanta, GA: U.S. Department of Health and Human Services, Public Health Services.

ToxGuide™ for Lead Pb

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U.S. Department of Health and Human Services
Public Health Service
Agency for Toxic Substances and Disease Registry
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ATSDR
AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

Chemical and Physical Information

Lead is a Metal

- Lead is a naturally-occurring bluish-gray metal that is rarely found in its elemental form, but occurs in the Earth's crust primarily as the mineral galena (PbS), and to a lesser extent as anglesite ($PbSO_4$) and cerussite ($PbCO_3$).
- Lead is not a particularly abundant element, but its ore deposits are readily accessible and widely distributed throughout the world. Its properties, such as corrosion resistance, density, and low melting point, make it a familiar metal in pipes, solder, weights, and storage batteries.
- Natural lead is a mixture of four stable isotopes, ^{208}Pb (51–53%), ^{206}Pb (23.5– 27%), ^{207}Pb (20.5–23%), and ^{204}Pb (1.35–1.5%). Lead isotopes are the stable decay product of three naturally radioactive elements: ^{206}Pb from uranium, ^{207}Pb from actinium, and ^{208}Pb from thorium.

Routes of Exposure

- Inhalation – primary route for occupational exposure. Larger particles (>2.5 µm) that are deposited in the ciliated airways (nasopharyngeal and tracheobronchial regions) can be transferred by mucociliary transport into the esophagus and swallowed.
- Oral— Primary route of exposure for the general population.
- Dermal – Studies in animals have shown that organic lead is well absorbed through the skin.

Lead in the Environment

- Lead is dispersed throughout the environment primarily as the result of anthropogenic activities.
- In the air, lead is in the form of particles and is removed by rain or gravitational settling.
- The fate of lead in soil is affected by the adsorption at mineral interfaces, which are dependent upon physical and chemical characteristics of the soil (e.g. pH, soil type, particle size, organic matter content).
- Sources of lead in dust and soil can include lead from weathering and chipping of lead-based paint from buildings, bridges, and other structures.
- The solubility of lead compounds in water is a function of pH, hardness, salinity, and the presence of humic material. Solubility is highest in soft, acidic water.

Relevance to Public Health (Health Effects)

Health effects are determined by the dose (how much), the duration (how long), and the route of exposure.

Minimal Risk Levels (MRLs)

- MRLs were not derived for lead because a clear threshold for some of the more sensitive effects in humans has not been identified.
- Models that predict blood lead levels (PbBs) corresponding to specific exposure scenarios have been used for assessing lead health risks (see section 3.3.5 and Appendix D of the profile).

Health Effects

Hematological
- Decreased activity of several heme biosynthesis enzymes at <10 µg/dL.

Gastrointestinal
- Colic in children – 60-100 µg/dL.

Cardiovascular
- Elevated blood pressure – <10 µg/dL.

Renal
- Decreased glomerular filtration rate at mean PbB <20 µg/dL.

Neurological
- Encephalopathy – 100-120 µg/dL (adults) 70–100 µg/dL (children).
- Peripheral neuropathy – 40 µg/dL.
- Neurobehavioral and neuropsychological effects in adults – 40-80 µg/dL.
- Cognitive and neurobehavioral effects in children at <10 µg/dL.

Reproductive
- Reduced fertility – >40 µg/dL.

Children's Health

- Children are more vulnerable to the effects of lead than adults.
- The most common source of lead exposure for children is lead-based paint.
- Lead exposures during infancy or childhood may result in anemia, neurological impairment, renal alterations, colic, and impaired metabolism of vitamin D.
- Lead exposures either in utero, during infancy, or during childhood may result in: delays or impairment of neurological development, neurobehavioral deficits including IQ deficits, low birth weight, and low gestational age, growth retardation, and delayed sexual maturation in girls.
- Ensuring a diet that is nutritionally adequate in calcium and iron may decrease the absorbed dose of lead.

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